

A CORRELATION STUDY OF ACCUPLACER MATH CUT SCORES, DEVELOPMENTAL
MATH MODULES, MATH PREP, AND ACADEMIC PREPAREDNESS IN THE SHARED
PRACTICAL NURSING PROGRAM AT NICOLET AREA TECHNICAL COLLEGE

by

Connie Gensler

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Dr. Howard Lee
Investigation Advisor

The Graduate School
University of Wisconsin-Stout
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The Graduate School
University of Wisconsin Stout
Menomonie, WI 54751

ABSTRACT

Gensler	Connie	R.
(Writer) (Last Name)	(First)	(Initial)

A CORRELATION STUDY OF ACCUPLACER MATH CUT SCORES, DEVELOPMENTAL MATH MODULES, MATH PREP, AND ACADEMIC PREPAREDNESS IN THE SHARED PRACTICAL NURSING PROGRAM AT NICOLET AREA TECHNICAL COLLEGE

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The purpose of this study is to determine the correlation between the current math ACCUPLACER cut score of 80% and the successful completion of the developmental math modules or math prep to academic preparedness in the shared practical nursing program at Nicolet Area Technical College. The study included three cohorts of nurses from June 2001 through June 2003. Seven questions were specifically addressed by the study. These questions were: 1) Of the number of students applying for the practical nursing program, how many achieve the 80% on the ACCUPLACER placement test?, 2) Is there a differential impact on student success on the first nursing math test based on developmental math modules, math prep, or an 80% on the first ACCUPLACER try?, 3) What is the relationship between students' grades

in math prep and their score on the first nursing math exam? 4) What is the relationship of students' scores before taking the developmental math modules and their score on the first nursing math exam?, 5) What is the relationship of students ACCUPLACER cut score of 80% or better and the score on their first nursing math exam?, 6) What is the relationship of students' scores before taking math prep or developmental math modules and their score on the first nursing math exam? and, 7) What is the number of practical nursing students that failed the practical nursing program based on inability to pass a nursing math exam on their third attempt?.

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Chapter One

Introduction

Background

Perhaps no aspect of schooling is as pervasive and misunderstood as placement testing. Placement testing is designed to assist educational institutions in placing students into appropriate courses, however, education institutions differ greatly with respect to composition of student body, course content and course rigor. Academic advisors placing students into courses should not rely on placement test scores alone, but rather, take into consideration students previous course work, grade point average, and motivation as other predictors of student success.

Many students enter post-secondary institutions without adequate preparation for the level and quality of work required in courses and programs. It is an opportunity and a challenge to identify these students through placement testing and help them achieve their academic goals. The very issue of placement testing has concerned educators and administrators for some time (College Entrance Examination Board, 1993).

Nicolet Area Technical College (NATC), like most Wisconsin Technical Colleges (WTCS), has struggled over the past few years with issues related to accuracy in student placement (T. Raykovich, Testing Specialist, personal communication, February 11, 2003). Nicolet's mission statement is a reminder of their commitment to "deliver superior community college education that transforms lives and enriches communities" (NATC, 2003b, p. 4). Nicolet College is committed to an open-door policy for admission to the college for all students (NATC, 2003b).

Because of the diverse student population Nicolet College serves, the need for effective entry level assessment is critical. One research study suggests that placement testing may be a useful predictor of students' academic success (Armstrong, 1991).

If students are able to achieve their academic goals, then Nicolet has been successful in their retention efforts. According to Morante (cited in Spann & Calderwood, 1998), a college cannot be truly effective without having a focus on retention, and a well-implemented placement process is essential for retention. If colleges want to succeed, a placement test that provides information about students' basic skill levels is crucial. Good retention efforts begin with accurate information about students' skills and appropriate placement in courses.

One evaluation tool used by NATC that measures student skills is the ACCUPLACER. This test is designed to assist colleges and university systems in placing students into developmental and beginning college level courses. The ACCUPLACER is most commonly used for determining whether post-secondary students are ready for placement into beginning level courses (Sireci & Dillingham, 1999).

Nicolet began using ACCUPLACER for entrance placement in late 1996. ACCUPLACER is a computerized placement test(s) (CPTs), designed to determine academic preparedness in three basic skills areas; reading, writing and arithmetic (Nicolet Area Technical College, 2003a). ACCUPLACER scores are reported on two scales: percent scores and total right scores: either score can be used to make placement decisions. The total right score is the estimated number of items the student is expected to answer correctly if she/he were administered the entire 120-items composing the bank (Sireci & Dillingham, 1999).

At Nicolet, ACCUPLACER cut-scores were originally set by converting ASSET scores that had been used at Santa Fe Community College in Florida. For Nicolet's shared programs,

NATC follows placement testing guidelines and cut scores set by the degree awarding institution. Currently, seven of the 16 Wisconsin Technical Colleges test using ACCUPLACER for student placement upon admission (Long, 2003).

Given the diversity of students and courses across colleges and universities, the College Board does not mandate specific cut scores on the ACCUPLACER tests for placing students into specific courses (College Entrance Examination Board, 1993). However, in Nicolet's shared practical nursing (PN) program, students must achieve at the 80% (cut score) on the arithmetic section of the ACCUPLACER. According to Zoe Cujak (Nursing Program Director, Fox Valley Technical College, personal communication, November 12, 2003), the cut score of 80% was established to reflect a 10th grade math competency required for practical nursing program. Students not reaching the cut score of 80% are given the choice to "brush up" on their math skills and retake the ACCUPLACER, take a math prep course, or elect to complete the developmental math modules via independent study in the basic education learning lab.

If the student chooses the math prep course, the student is made aware that they must achieve a final grade of "C" or better to be eligible for the practical nursing program. The math prep course is designed to prepare the new or returning student to succeed in college math courses. Emphasis includes eliminating math anxiety; computing whole numbers, fractions, decimals, and percent; solving word problems; and introducing basic algebra and geometry problems.

If the student opts for the math modules, they are instructed that they must achieve an 85% on each of the five math modules before they may be admitted into the PN program. According to Zoe Cujak (Nursing Program Director, Fox Valley Technical College, personal communication, November 12, 2003), achieving an 85% was established to relate it to the

clinical experience of a nurse. A nurse caring for 10 patients that required drug dosage calculations, and the nurse calculated 85% of the equations correctly, it would mean that 8.5 patients received the correct medication and 1.5 medications were given in error. Over time the drug dosage calculation error becomes quite significant.

Module one consists of fractions, ratio, proportions, and percents. Module two consists of Roman numerals, metric and temperature conversions. Module three contains the household and apothecary system. Module four covers abbreviations and drug dosages while the final module relates to infant and children drug dosage calculations. Completion of these modules may take weeks to months, depending on several factors. At the present, there is no time limit in place for completion of the modules. These modules have been developed by faculty at Fox Valley Technical College (FVTC), one of the WTCS, which is the degree awarding institution of the practical nursing diploma. According to Barb Hummel (Goal Math Department Chair, personal communication, September 16, 2003), the math modules have been in place for use since 1983 and faculty have noted an increased passing rate on math exams since starting to use the modules.

When students are admitted into the program, students are instructed that in Basic Nursing I (510-311), students must successfully demonstrate an 85% competence in basic math. In Basic Nursing II, (510-321) students must successfully demonstrate a 90% competence in medication mathematics. Failure to achieve either of these two competencies will prevent the student from progressing in the practical nursing program (FVTC, 2002).

On the first math exam, practical nursing students are expected to solve simple math problems using basic math skills. This includes using roman numerals, reducing fractions, addition and subtraction of fractions, multiplication and division of fractions, mixed numbers and

improper fractions, addition, subtraction, multiplication and division of decimals, changing fractions to decimals, and calculations with percent.

The second math exam consists of the target competencies that include calculating medication dosages using basic math skills, ratio, proportion, and basic formulas.

Upon entering the second semester of the practical nursing program students are expected to show continued competence in math. The first exam given in this course is approximately 50% math questions and is averaged into the student's final course grade.

Statement of the Problem

It seems that NATC is not sure if the cut scores on the math Accuplacer are appropriate. The results might be that students are failing the math exams. While the cut scores of the math Accuplacer has been used at NATC, the correlation has never been determined. A study to determine the correlation between entrance math cut scores on ACCUPLACER, completion of the math prep course or remedial developmental math modules, and the student's ability to achieve the required score on the nursing math exams to prove math competence would be of great value.

Purpose of the Study

The purpose of this study was to determine the correlation between the current math ACCUPLACER cut score of 80% and the successful completion of the math prep course or developmental math modules to academic preparedness in the shared practical nursing program at Nicolet Area Technical College. This study will include three cohorts of nurses from June 2001 through June 2003.

This study will determine if the shared practical nursing program ACCUPLACER math cut score of 80% correlates with students' success in their entry level math nursing course. This study will determine if the developmental math modules and/or math prep course adequately prepare the practical nursing students for the math in their entry level nursing course.

Research Questions

This study will answer the following questions:

1. Of the number of students applying for the practical nursing program, how many achieve the 80% on the ACCUPLACER placement test?
2. Is there a differential impact on student success on their first nursing math test based on developmental math modules, math prep, or an 80% on first ACCUPLACER try?
3. What is the relationship between students' grades in math prep and their score on the first nursing math exam?
4. What is the relationship of students' scores before taking the developmental math modules and their scores on the first nursing math exam?
5. What is the relationship of students who achieved the ACCUPLACER cut score (80% or better) and their score on the first nursing math exam?
6. What is the relationship of students' scores before taking the math prep course and their scores on the first nursing math exam?
7. What is the number of practical nursing students that failed the practical nursing program based on inability to pass a math exam on their third attempt?

Justification of the Study

A study of the correlation of ACCUPLACER math cut scores, the math prep course, and the development math modules to academic preparedness in the practical nursing program can be justified on several levels:

1. The Higher Learning Commission (HLC), formerly referred to as North Central Association (NCA), require that NATC provide patterns of evidence within the institution that promote improvements in teaching and learning. Fulfilling HLC recommendations require NATC to engage in continuous quality improvement of our assessment practices including placement testing.
2. Due to the increased demand in the need for practical nurses in Wisconsin and across the country, research needs to be conducted to determine if NATC is creating artificial barriers for the student to be successful in the practical nursing program. Research needs to be done to determine the number of students not completing the practical nursing program based on performance of math exams.
3. Data from this research will assist the WTCS nursing programs as they move forward on their statewide project entitled “seamless curriculum” as they determine the math cut scores for practical nursing programs they offer. The intent of “seamless curriculum” is to facilitate a seamless career path for students moving from practical nursing to associate degree nursing. The math competency expected is the same for practical nursing students and associate degree nursing students.
4. Data from this research will assist FVTC and NATC to develop math modules that are consistent with the math required in nursing curriculum. It is imperative that math taught

in the math modules is consistent with math needed to perform medication dosage calculation skills to safeguard nurses against medication errors.

Significance of the Study

This study is important for the following reasons:

1. This study will be significant to current diploma, associate degree and baccalaureate degree nursing programs in the Wisconsin. This study may help determine if current admission entrance testing actually identifies what we want the student to know. It may help determine if math for medication and dosage calculation should be taught as a separate course specific for occupational programs such as practical nursing, associate degree nursing, medical assistants and medication aides, and others administering medications.
2. This study may be of significance to the National League for Nursing Accrediting Commission (NLNAC). NLNAC is nursing's accrediting body that looks at quality issues within nursing programs. One of the criteria examined is curriculum. Math is a significant part of nursing curriculum and weighs heavy in pharmacology courses and in clinical experiences when students are determining dosage calculation. NLNAC also reviews our State Board of Nursing pass rates. The NCLEX exam does contain several mathematical equations related to dosage calculation.

Limitations of the Study

The limitations of this study are as follows:

1. The results of this research will be limited to influencing the program and students attending NATC only. Implications should not be made to other programs.

2. This study includes the small population of practical nursing students at Nicolet Area Technical College. The shared practical nursing program started in June of 2001 and is limited to 14-18 per year. This study group will include all students entering the program June 2001, June 2002, and June 2003. Generalizations to other populations cannot be made.

3. Of college entrance tests available, this study is limited to only the ACCUPLACER placement test. Students entering the PN program at NATC with previous American Counsel of Testing (ACT), Scholastic Aptitude Test (SAT), or ASSET scores were required to take ACCUPLACER.

4. This study is limited to only one set of developmental math modules. These math modules were developed by faculty at FVTC specific to their health programs with no input from faculty at NATC.

5. This study is limited to only practical nursing students. Implications to other programs cannot be made.

6. This study is limited to ACCUPLACER, math prep, and developmental math modules.

7. This study did not address other variables such as IQ, math courses taken in high school, preparation for the ACCUPLACER, consistency of math modules, math “test anxiety” of students, testing environment, computerized testing anxiety, study habits of students, learning disabilities of students, or for other factors affecting success in the math part of the nursing curriculum.

Assumptions of the Study

The assumptions of this study are as follows:

1. This study assumes that the developmental math modules and the math prep course are more closely linked to the practical nursing curriculum than the ACUCPLACER math test questions.
2. This study assumes that the ACCUPLACER is a valid placement test.
3. This study assumes that the practical nursing students were adequately prepared prior to taking their nursing math exam.
4. This study assumes that practical nursing students have access to resources and faculty to address questions related to nursing math prior to exams
5. This study assumes that there is instructor inconsistency in expectations on the math exams as it relates to math equations and values.
6. This study assumes that there is instructor inconsistency and bias when grading math exams.

Definition of Terms

The following terms were used in this study:

ACCUPLACER – A software package from the College Board currently having three components: Computerized Placement Tests, Computerized Placement Management Software, and Placement Research Service (College Board, 2003).

American Counsel of Testing (ACT) – An achievement test that measures English, reading, math and science to be used in conjunction with other information for course placement.

ASSET – An achievement test that measures English, Reading and Math, to be used in conjunction with other information for course placement.

Associate Degree – A two-year degree, with a range of credits from 68-72.

Baccalaureate Degree – A four-year degree with a minimum credits of 120.

Brush-up – Activities/lessons students are able to practice that will better prepare them for taking the ACCUPLACER placement test. Lessons and activities are on line at various web sites.

College Board – The College Board is a national association that connects students to colleges. Their mission is to prepare students for college, providing assistance with financial aid, guidance/counseling, admissions, assessment, and teaching and learning.

Computerized Placement Tests (CPTs) – Computerized placement tests are administered on a computer. Students read the instructions and questions on the computer monitor and select their answers using the keyboard of the computer mouse (College Board, 1997).

Cut Score – According to Roberts (1994), the score at which placement is determined, i.e., a student scoring below the cut score would be placed in a lower level course.

Higher Learning Commission – Is one of six regional institutional accrediting associations in the United States. Their mission is to assure and advance the quality of higher learning by examining patterns of evidence that each member institution meets their criteria (Higher Learning Commission, 2001).

Math Modules – Independent math modules with emphasis on math for nurses developed by Fox Valley Technical College, General Studies Division.

Math Prep - A course designed to prepare the new or returning student to succeed in college math courses.

Nicolet Area Technical College – A public community college serving Northern Wisconsin, south of Rhinelander. The district is comprised of Oneida, Vilas, and Forest counties and portions of Iron, Lincoln, and Langlade counties. Nicolet serves over 1500 program students each semester (NATC, 2003b).

Practical Nursing Program – A 28 credit technical diploma program offered by Fox Valley Technical College. This program is approved by the State of Wisconsin Board of Nursing. Graduates are eligible to write the National Council of State Board Licensure Examination to become a licensed practical nurse. The practical nurse works with and under the supervision of the registered nurse as members of the health care team (Fox Valley Technical College, 2003)

Scholastic Aptitude Test –An achievement test to measure English, Writing and Math that can be used in conjunction with other information to determine course placement.

Seamless Nursing Curriculum – A statewide project in Wisconsin, where all 16 Wisconsin Technical Colleges will have standardized admission criteria and curriculum for practical and associate degree nursing program.

Shared program – A shared program is one in which a district holds State Board approval to offer a program, but is willing to enter into a formal agreement with one or more districts wishing to share the program (Wisconsin Technical College Board, n.d.).

Success – Achieve an 85% on first nursing math exam and a 90% on the second nursing math exam. Total attempts allowed to achieve success are three for each exam.

Technical Diploma – A one or two year degree with a range or credits of 28-32.

Methodology

This is a combination of quantitative and qualitative methods. Chapter Two will be a review of literature. Chapter Three contains a discussion of methods and procedures applied in this study. The results of the methodology will be presented in Chapter Four. Chapter Five provides a summary, conclusion, and recommendations for further study.

Chapter II

Literature Review

The purpose of this study is to determine the correlation between the current math ACCUPLACER cut score of 80% and the successful completion of the math prep course or developmental math modules to academic preparedness in the shared practical nursing program. This study will include three cohorts of nurses from June 2001 through June 2003.

This chapter provides a brief review of the literature on math competence and academic preparedness of practical nursing students. This chapter is organized within the following four divisions: a) the ACCUPLACER college entrance examination, b) history of developmental nursing math modules, c) math competency of nursing students, and d) medication calculation skills of the beginning nurse.

The ACCUPLACER College Entrance Examination

To provide both access and excellence in postsecondary education, an effective placement program must assess basic skills and place students in appropriate coursework levels at the beginning of their college careers. The ability of college placement tests to serve as reliable and valid indices of academic preparedness and to be used in decision-making processes regarding placement or exemption from remedial coursework, and appropriate curriculum is dependent on the meaning and usefulness of the information the tests convey (Smittle, 1993).

The ACCUPLACER is a computer program designed to facilitate the evaluation and placement of college students into appropriate courses. According to the College Board (2003), the ACCUPLACER was introduced in 1985 and was meant to place students in English and mathematics courses. The ACCUPLACER consisted of four tests at that time: reading

comprehension, sentence skills, arithmetic, and elementary algebra. According to the College Board (2003) the ACCUPLACER now consists of nine different sub tests.

The purpose of the ACCUPACER is to determine which course placements are appropriate and to determine if remedial work is needed. The ACCUPLACER is not meant to serve as an admission test (College Board, 2003).

Each test in the ACCUPLACER is designed to evaluate a student's ability in a specific academic area. The ACCUPLACER is composed of four sections: Computerized Placement Tests (CPTs), Computerized Placement Advising and Management Software (CPAMS), Placement Validation and Retention Service (PVRs), and School to College Placement Articulation Software Service (PASS) (Impara & Plake, 1998). This literature review will cover only the CPTs, their reliability and validity.

Nicolet College has been using ACCUPLACER computerized adaptive testing since 1999. According to the College Board (2003), the ACCUPLACER tailors the test to each student using an item-selection algorithm. The purpose of the algorithm is to match item difficulty to examinee proficiency (College Board, 2003). The student's response to a question then determines the level of difficulty for the subsequent questions.

The math portion of the ACCUPLACER includes 16 questions from three broad categories: 1) operations of whole numbers and fractions including addition, subtraction, multiplication, division, recognizing equivalent fractions, and mixed numbers; 2) operations with decimals and percents including addition, subtraction, multiplication, division, percent problems, decimal recognition, fractions, percent equivalencies, and estimation problems; and 3) application and problem solving including rate, percent, measurement problems, and geometry (College Board, 1997). While students typically rely on the use of

calculators to complete math exam problems in high school or on the ACT, calculators are not to be used while taking the ACCUPLACER.

According to the College Board (2003), ACCUPLACER has been measured for test score consistency. Test reliability is often confused with validity. It is important to note that just because a test is reliable, does not necessarily mean that it is valid. Test-retest reliability indicates the correlation between the scores of a test given to the same group of people on two separate occasions. In terms of ACCUPLACER test-retest reliability, caution must be exercised in interpreting the results in that the arithmetic sub-test $n = 96$. With that said, the arithmetic test-retest reliability estimates were fairly good ranging from 0.78 to 0.96 (College Board, 2003).

The internal consistency or split method of determining reliability refers to splitting up parts of the test and determining consistency (T. Raykovich, Career Counselor/Assessment Specialist, personal communication, September 26, 2003). The internal consistency of the arithmetic sub-test was acceptable at 0.92.

According to the College Board (2003), the standard error of measure was calculated at selected score intervals, (every 10 points). The standard error of measurement refers to the level of inherent error in a given test score. For example, if a student earns a total right score on ACCUPLACER of 40 and the standard error of measurement is 4, the student's true score is somewhere between a 36 and 44. According to the College Board (2003), ACCUPLACER divided the total right score by intervals of ten and the standard error of measure ranged from 3.6 to 10.0. The highest standard error of measure scores centered around the 70 to 80 total right score range. The shared practical nursing program math cut score is 89 equivalent to 80% cut score. Obviously this is not a desirable statistic.

Validity is particularly important with ACCUPLACER in that ACCUPLACER may be used for different purposes such as college admissions, accessing basic academic skill levels, and course/program placement. According to the College Board (2003), it is the responsibility of the test users to evaluate the findings to determine if ACCUPLACER is the appropriate test to meet their needs. The importance of this statement cannot be ignored, especially when many colleges today are using valid standardized test instruments to make important decisions. Many times these decisions are based on inferences drawn through test scores that are simply inappropriate (T. Raykovich, Career Counselor/Assessment Specialist, personal communication, September 26, 2003).

In terms of using the ACCUPLACER to identify academic deficiencies for placement into development courses, it is important that the test content be relevant to the subject matter. The College Board has conducted numerous quality control checks on ACCUPLACER test items to determine that they are relevant to the domain assessed, thereby demonstrating content validity (College Board, 2003).

As for the predictive validity of the ACCUPLACER, the College Board conducted a large-scale predictive validity study involving 50 educational institutional, 38 of which were two-year colleges and 12 were four year colleges (College Board, 2003). According to the College Board (2003), the norm group for the arithmetic section numbered 6114 students. Study results revealed median correlation within colleges between arithmetic test scores and grades in general mathematics and arithmetic courses ranging between .31 and .38. These correlation coefficients revealed we can increase our ability to predict course grades using ACCUPLACER by 10% to 14% (College Board, 2003).

In October of 1997, Nicolet College performed its own placement test validity study of the ACCUPLACER entrance test. The purpose of this study was to: measure students' reactions to computerized testing, measure the face validity of the ACCUPLACER test, and measure the criterion validity of the ACCUPLACER (Luster, 1997). According to Luster (1997), ratings for ACCUPLACER doing a good evaluation of math skills were significantly high. In addition, Luster's study showed that students judged the math ACCUPLACER test as too difficult and a substantial number of students rated the math test as too complex. The results of Luster's findings were: ACCUPLACER had moderately good face validity and significant concurrent validity coefficients were found for all three sub tests (reading, writing and math) of the ACCUPLACER (Luster, 1997).

The ACCUPLACER entrance examination is designed for students entering a community or technical college. The ACCUPLACER is one reference used by academic advisors at Nicolet College to determine course placement and serve as a tool for retention.

The History of the Developmental Nursing Math Modules

There are no written artifacts on the history or the development of nursing math modules. Information in this section is provided by interview of a faculty member in the Goal Oriented Adult Learning Lab (GOAL), at Fox Valley Technical College, Appleton, Wisconsin.

According to the Barb Hummel (GOAL Math Department Chairman, personal communication, September 16, 2003), the nursing math modules have been in place since 1983. Prior to this, students entering the practical nursing program were not tested for math competency. Nursing students had math as part of a 5 credit core nursing course. Many students were unsuccessful at the math portion of this 5 credit core course. As a result, students were required to repeat the entire 5 credit core nursing course and attend GOAL lab. During Goal lab,

instructors had limited time to teach math concepts ranging from whole numbers to nursing calculations. This was overwhelming to both instructor and students.

When the individual math modules were initially developed, nursing faculty provided the course developer with examples of what the students needed to be able to do and what conversions needed to be memorized for the practical nursing program. According to Hummel (personal communication, September 16, 2003), there was no research used to support the effectiveness of the nursing math modules, but Hummel stated that she believed nursing instructors would have noted an improvement in the class work of students and an increased passing rate on the math exams. If this were not the case, it would not be a prerequisite for program readiness for students scoring below 80% on the ACCUPLACER (B. Hummel, personal communication, September 16, 2003).

As for face validity of the math modules, the first module is a review of percents, ratios, and proportions. Though for some this may be considered “just math,” it reviews the skills students need to be successful in the remaining units, since the nursing department wants conversions done via proportions rather than unit cancellation. The second module covers Roman numerals and metric and temperature conversion. In this unit the student should be able to convert milliliters to liters, grams to micrograms, and express Roman numerals and Arabic numerals. Unit three of the modules gets more nursing specific with the conversions of kilograms to pounds, minums to drams, teaspoons to milliliters. This is specific to the household and apothecary system. Unit four is also specific to nursing in that it covers nursing abbreviations as it relates to drug dosage calculations. The last module is nursing math via word problems, for example, a question may read “the recommended dose of Phenobarbital for a 2500 gm neonate is 8mg/kg/day. How much should the newborn receive over 24 hours?”

The nursing math modules consist of five separate modules. Students must demonstrate competency by completing the individual module followed by a competency exam achieving an 85% or better on each module. Highly motivated students might complete the entire five modules in two weeks, whereas other students may require several months to complete the modules. According to Hummel (personal communication, September 16, 2003), some students never complete the modules, excluding them from entry into the practical nursing program. Completion deadlines are not set for students working on the modules. Students work independently and on average complete the modules in 4-6 weeks.

According to Hummel (personal communication, September 16, 2003), revisions to the modules were made to accommodate alternative delivery methods such as the Internet. Course materials were given to nursing program faculty spring 2003 to make revisions if needed. At this time, no revisions have been made.

Nursing faculty at Nicolet support use of the math modules developed by Fox Valley Technical College (L. Mangles, personal communication, October 20, 2003) A study by Hutton (1998) found that math tutorials and self-help booklets in math can help raise test scores to an acceptable level in a short amount of time.

According to Shore and Shore (2003), math skills that health care professionals need to know are often not taught in their developmental math courses and have little relevance to their career goals. Shore and Shore (2003) suggested that with the high demand for nurses, it is critical that these students are prepared for the math they will encounter on the job, with a goal of achieving learning in a career-related context.

Math Competency of Nursing Students

Mixing the words nurse and math tend to create anxiety among most nursing students. Most nursing students indicate that the primary reason for choosing the profession of nursing is the desire to care for and help others. Nursing students become concerned when they learn that math is a significant part of the practical nursing program curriculum. Students become even more concerned when they realize that lack of proficiency in math may exclude them from progressing in the practical nursing program. For this reason and the safety of patients, mathematical competency for practical nursing students should be addressed.

Approaches to learning nursing math are numerous, however, nursing math remains a difficult topic for the nursing student, the instructor, and the practicing nurse (McCort, 1987). According to McCort (1987), not only do student nurses need an improved understanding of basic math (multiplication of fractions, division, ratio and proportion), they also need to understand math specific to nursing. Nursing math includes converting between the metric, apothecary, and household systems. The metric system includes Arabic numbers and decimals used for measurement. Examples include the liter, gram, and meter. The apothecary system uses the basic unit of weight, the grain. The apothecary system uses Roman numerals and fractions to express units. Examples include drams and ounces. The household system includes the use of teaspoons, tablespoons, drops, and ounces, all are important in educating patients how to take medications at home.

Nursing students as well as practicing nurses continue to struggle with math competency as it relates to nursing. According to Blais and Bath (1992), the most frequent type of mathematical errors were conceptual errors (setting up the problem) and arithmetic errors (incorrect addition, subtraction, multiplication, division, decimals, and fractions). According to

Flynn and Moore (1990), graduate nurses made errors at a rate of 1 in 12 when performing written calculations. In a study by Ashby (1997), 56.4% of medical-surgical practicing nurses could not calculate medications correctly in 90% of the problems given to complete. These statistics should alert nurse educators and practicing nurses of the need for ongoing evaluation of student basic math skills and provide continuing education in math skills for practicing nurses. According to Lenore Mangles (personal communication, November 4, 2003), frequently, incorrect calculated medication dosages, is the cause of medication errors. Mangles (personal communication, November 4, 2003), estimated that on a 10 point math exam, a student missing one question would have a test score of 90%. Looking at this from patient care, this same scenario could mean that out of 10 patients receiving medications, the first nine received the correct dose, the tenth patient received the wrong dose of medication. It is imperative that nurses ensure patient safety. One mechanism to ensure safety is to educate nursing students in math that is relevant to the math skills encountered on the job to help prevent the risk of medication errors.

One should not discount the study by Hutton (1998) that showed that the type of math education received in nursing curriculum positively influenced the performance of newly licensed nurses in a written math drug calculation exam. This is important to note since the practical nursing curriculum is currently designed with the expectation that the student has met the math entry requirement as part of admission to the nursing program. Therefore, the expectation is that the student comes to the practical nursing program with the required math competency and math is not taught in the curriculum.

Hutton (1998) suggested that testing students prior to admittance into a nursing program may cause the student to be denied an opportunity for a career in nursing. According to Hutton

(1998), there is no recommended minimum qualification in math required to enter the majority of nursing programs. Hutton (1998) suggested that math performance as part of criteria for selection into a nursing program may discriminate against a potentially good student nurse candidate. This statement should not be taken lightly, considering Wisconsin is facing a nursing shortage that projects to extend to at least the year 2020 (L. Mangles, Associate Degree Program Director, personal communication, October 13, 2003). According to Mangles (personal communication, October 13, 2003), it is important for technical colleges and universities to do all they can to limit the number of barriers for students admitted into nursing programs. One way to help with this is early and ongoing assessment of student's math competency. Flynn and Moore (1990) suggested that students who cannot perform math calculations correctly should be identified prior to entry into nursing clinical courses and be provided with opportunities for remediation.

Medication Calculation Skills

Safe administration of medications is a critical nursing skill, however, with the ongoing rapid updates of technology in healthcare, the frequency of beginning or practicing nurses needing to perform other than very simple medication calculation skills for drug administration is low (Cartwright, 1996a). The use of intravenous pumps containing drip rate calculations, unit dose drug packaging, bar coding of medications, give nurses less and less opportunity to maintain their mathematical skills. For the safety of patients, nurses need to maintain competency in their math skills regardless of the changes in technology. It is up to employers to ensure that nurses have continued education, and are able to demonstrate competency in performing medication dosage calculations skills before coming in contact with patients.

Mathematical proficiency is a prerequisite to the performance of many nursing functions such as dosage calculation, intravenous regulation/calculation, and intake and output calculation (Bindler & Bayne, 1984). In a descriptive study by Bindler and Bayne (1984) they indicated that a substantial number of student nurses did not possess the basic mathematical skills necessary to function as nurses. The authors concluded that dosage calculation difficulties had not improved as a result of lack of mathematical skills. This study should be of significance for nurse educators at NATC, as it alerts to the need for students to demonstrate mathematical competency throughout the practical nursing program.

According to Gladstone (1995), it is often taken for granted that nurses who prepare medications for drug administration have been adequately trained for the skill. Whether a student nurse or practicing nurse, consumers expect that medications be adequately and safely prepared for administration by trained personnel. Nursing curriculum teaches to the seven rights of medication administration; the right patient, right drug, right dose, right time, right route, right reason and right documentation. A study by Hodge-Blakeman (1999), found that as many as 1 in 5 medications were administered in error with 33% of these errors a result of the wrong dose. Worrell and Hodson (1989) concluded that the administration of a wrong dose of medication is ranked second, with the omission of a drug being the most frequent error reported.

In a study by Santamaria, Norris, Clayton, and Scott (1997), of 220 graduate nurses, 58% were unable to calculate drug dosage accurately even when allowed the use of a calculator. The use of calculators in the practical nursing program is prohibited during exams, however, when in the clinical setting or once graduated, students may use a calculator to assist in dosage calculation.

An approach suggested by Connors and Tillman (1993), in assisting students demonstrating math competency in medication calculation skills is through the use of an algorithmic calculator. This algorithm calculator would assist the student in consistently setting up the problem by prompting the student for information needed for drug dose or drip rate. This is significant, as “setting up the problem” was identified earlier in a study by Blais and Bath (1992) as one factor associated with incorrect dosage calculation.

Another factor for nursing faculty to recognize is the varied learning styles of the students as they attempt to complete medication calculation skills. Results of a correlation study of ability to calculate drug doses and learning styles of nursing students found that there was indeed a positive correlation between the two Blais and Bath, (1992). Identified by Blais and Bath (1992), were two approaches used in completing medication calculation equations; the inchworm approach, which is a step-by-step processing of math, and the grasshopper approach, which describes an all-at-once mental processing. The latter encourages mental visualization during drug dosage calculation and those using this approach performed better on dosage calculation questions (Blais & Bath, 1992). This is an important teaching strategy for nursing faculty to be aware of and emphasize. If nursing faculty can incorporate teaching methodology to address learning styles, then it would seem that math ability of students might improve.

Overall, the findings from this literature review reveal that there are significant problems with the ability of student nurses, graduate nurses and practicing nurses demonstrating mathematical competency as it relates to the fundamental skills of nursing.

Chapter III

Methodology and Procedure

This chapter provides a description of: 1) the characteristics and selection of the subjects, 2) instrumentation, 3) method of data collection, 4) method of data analysis, and 5) limitations to methodology.

Selection of Subjects

Forty-five practical nursing students participated in this study. The sample selection was drawn from all the students entering the practical nursing program June of 2001, 2002, and 2003, at Nicolet Area Technical College. Students selected had previously completed course work in nursing assistant, communications, and anatomy and physiology.

The sample of students was mainly Caucasian females, which is representative of the profession of nursing in the state of Wisconsin. Approximately 18% (6) of the students were male. Cultural diversity was not established for this study. Student ages ranged from eighteen to middle forties.

Of the forty-five students participating in the study, approximately 7% held transfer credits from other WTCS or university system. Approximately 24% of the students either withdrew, dropped, or failed the Associate Degree Nursing program over the past two years. This is typical of students entering the program in the past.

Instrumentation

The instruments used in this study included: a) a standardized score for prior math knowledge using the ACCUPLACER entrance examination, b) percentage score for math competency on individual math modules developed by FVTC, c) percentage scores representing

course grades in math prep course, and d) a spread sheet developed by the researcher to record the data gathered. Descriptions of each of these instruments follows.

Prior Math Knowledge

Prior math knowledge was determined by administration of the ACCUPLACER math entrance examination. The examination included 16 test questions from three broad categories: 1) operations of whole numbers and fractions; 2) operations with decimals and percents; and 3) application and problem solving including rate, percent, measurement problems and geometry. Students were not allowed to use calculators for the examination. Students were expected to achieve an 80% on the math ACCUPLACER entrance examination for admittance into the practical nursing program.

Competency in Math Modules

Competency in math modules were determined by students completing five math modules, achieving a minimum of 85% out of 100%, on each module. Each module consisted of fifty test items. The modules covered the following math skills: 1) fractions and percents; 2) Roman numerals, the metric system, temperature conversions; 3) household and apothecary system; 4) abbreviations and dosages; and 5) infant and pediatric drug dosages.

Competency in Math Prep Course Work

Competency in math prep course work, a 2 credit course, was determined by students achieving a letter grade of “C” or better in the course which is equivalent to an 73-76%. Content covered in the math prep course included whole numbers, fractions, decimals, ratio, proportions, percents and algebra. Grades were based on participation, quiz scores, and exam scores. There were a total of five quiz scores and four exam scores for this course. Fox Valley Technical

College, accepts either the developmental math modules or the math prep course, as meeting the remedial work required for entry into the practical nursing program. Students chose which of the two he/she would complete.

Recording the Data

A spreadsheet was developed by the researcher using the computer program Microsoft Excel. Columns identified were student identification, ACCUPLACER entrance examination score, math prep course grade, math module grades (separate columns for each of the five modules), and nursing math exam scores (three separate columns).

Data Collection

Data was collected by obtaining individual records of students entering the practical nursing program in June 2001, 2002, and 2003. Since Nicolet Area Technical College shares this program with Fox Valley Technical College, certain data was collected from each technical school. Math ACCUPLACER entrance examination scores were obtained on all participants in this study. For participants requiring remedial work, achievement scores in remedial work were obtained either from scores received on the five individual math modules or from grade rosters indicating the participant's math prep course grade. Students who did not need to take ACCUPLACER due to previous college transcript credit were asked to participate in this study by completing the math section of the ACCUPLACER entrance examination. All three students who had transcript credits willingly agreed to take the math ACCUPLACER exam for the purposes of this study.

Data was collected from faculty at Fox Valley Technical College, on students in the practical nursing program June 2001, 2002, and 2003. This data included student scores on

nursing math exams while a student in Nursing Basic 1 and Nursing Basic 2, which are core nursing courses for the practical nursing program.

All data gathered was entered onto a Microsoft Excel spreadsheet. Student names were changed to numerical data to ensure student confidentiality. Corresponding entrance ACCUPLACER scores were listed in the column next to the number representing the student. If the student scored below the 80%, their grade in math prep or scores on the five individual math modules were listed on the spreadsheet. In addition, each student's score on the three individual nursing math exams was recorded on this spreadsheet.

Limitations

Limitations to data collection included the relatively small number of students in the practical nursing program at Nicolet College. The shared practical nursing program has been active since June 2001, with a total of forty-five program students to date. Table 1, Frequency Distribution of Subjects shows the number of students in each category, the frequency, percent, valid percent and cumulative percent. Though forty-five students had taken the ACCUPLACER entrance exam, only 5 students participated in remedial math through the use of the developmental math modules. Nineteen students participated in remedial math via math prep coursework. For validity, this study should have a minimum of 30 matched samples of both developmental math modules and math prep coursework grades, therefore generalizability of the results should be used cautiously.

Table 1

Frequency Distribution of Subjects

Subjects	Frequency	Percent	Valid percent	Cumulative percent
Passed Accuplacer	21	46.7	46.7	46.7
Math modules	5	11.1	11.1	57.8
Math prep	19	42.2	42.2	100.0
Total	45	100.0	100.0	

Test validity was a limitation due to some students taking two or three attempts at passing the nursing math exams. Due to this limitation, the researcher considered only the first score earned on each of the two nursing math exams.

An overall limitation to the collection of data was the change in grading for the third nursing math exam. Student scores on the third nursing math exam were not taken into consideration for this correlation study. Course requirements changed for students entering the shared practical nursing program between June 2002 and 2003. The math grade earned on student's third nursing math exam were averaged into the course grade for students in the practical nursing program June 2002 and 2003, unlike the requirement of a 90% competency on the third nursing math exam for students in the practical nursing program, June 2001.

Data Analysis

For purposes of this study appropriate descriptive statistics were used to determine the relationship between the current math ACCUPLACER cut score of 80% and the successful completion of the nursing math exams in the practical nursing program. In addition, t tests were

performed to determine the significance of difference between the math modules, math prep course work, and achieving an 80% on the ACCUPLACER. Pearson R correlation coefficient was performed to determine the relationship of students ACCUPLACER scores and the scores on the first nursing math exam.

Chapter IV

Analysis and Discussion of Findings

In this chapter, the statistical outcomes corresponding to each of the research questions are presented. All appropriate descriptive statistics were performed including t tests and Pearson R correlation coefficient tests. The following research questions were addressed.

Research Question 1: Of the number of students applying for the practical nursing program, how many achieve the 80% on the ACCUPLACER placement test?

The number of students who applied to the practical nursing program between June 2001-2003 was 45. Of the 45 applicants, 21 scored an 80% or better on the ACCUPLACER math entrance exam. Table 2, Distribution of Data of Participants Scoring 80% on ACCUPLACER, shows the students who scored an 80% on the ACCUPLACER entrance exam and the scores on their first nursing math exam.

Table 2

Distribution of Data of Participants Scoring 80% on ACCUPLACER

	ACCP	Math	Mod 1	Mod 2	Mod 3	Mod 4	Mod 5	Test 1
		prep						
1	97							96
2	90							94
3	90							97
4	84							84
5	95							90
6	98							92
7	91							90
8	86							90
9	91							95

10	82	90
11	80	98
12	80	96
13	84	85
14	84	84
15	96	96
16	93	100
17	81	85
18	94	95
19	86	90
20	93	90
21	80	90

Note. ACCP. = ACCUPLACER; Mod = Module

In Table 3, Distribution of Data of Participants Scoring Less Than 80% on ACCUPLACER, shows the student and how they scored on the ACCUPLACER, math prep course grade earned, or scores on individual math modules, and student scores on their first nursing math exam. Of the 45 students applying to the practical nursing program, 24 students were not able to demonstrate competency in mathematical equations on the entrance examination.

The fact that 24 students could not achieve an 80% on the math ACCUPLACER, may be due to several factors. Most prevalent might be recent exposure to math. Most of the practical nursing students entering the program between June 2001-2003, were adults returning to school.

These students may have had little to no exposure to math since high school. This might indicate that students should consider self-help math tutorials or do some other type of brush-up on math prior to taking the ACCUPLACER entrance exam.

Table 3

Distribution of Data of Participants Scoring Less Than 80% on ACCUPLACER

	ACCP	Math prep	Mod 1	Mod 2	Mod 3	Mod 4	Mod 5	Test 1
22	49	A						82
23	56	C						65
24	73	A						80
25	39	A						W
26	20	B						W
27	63	C						W
28	21	A						W
29	43	A						94
30	22	B						78
31	39	B						96
32	63	C						W
33	31	A						78
34	68	B						96
35	30	B						90
36	43	B						80
37	70	B						72

38	38	B						W
39	70	B						82
40	46	A						94
41	68		85	85	85	89	68	66
42	68		85	85	85	89	-	85
43	60		90	100	92	91	92	90
44	39		93	72	60	83	52	82
45	58		91	85	88	78	85	90

Note. ACCP = ACCUPLACER; Mod = Module; Dashes indicate data is missing.W = Waived testing

Question 2: Is there a differential impact on student success on the first nursing math test based on developmental math modules, math prep, or an 80% on first ACCUPLACER try?

Multiple t-tests were performed on the data to address research question two. Table 4, T-test for Equality of Means for Math Modules, represents data from the math modules. Table 4, shows there was no statistical difference between those students who pass ACCUPLACER on the first try and those who completed the five individual math modules and their scores on the first nursing math exam ($t = 2.115$; $p = .095$). This may be the result of only five students choosing the developmental math modules as a form of remedial work. For concurrent validity, this study should have had a minimum of 30 matched samples of both developmental math modules.

Table 4

T-test for Equality of Means for Math Modules

		t	df	Sig (2-tailed)	Mean Difference
Accuplacer	Equal Variances Assumed	7.655	24	.000	29.4476
	Equal Variances not assumed	5.356	4.606	.004	29.4476
Test One	Equal variances assumed	3.284	23	.003	9.6000
	Equal variances not assumed	2.115	4.434	.095	9.600

Table 5, T-test for Equality of Means of Math Prep, indicates that there were statistically significant differences found between those who passed ACCUPLACER on the first try and those who took the math prep coursework and the scores on the first nursing math exam ($t = 2.972$; $p = .009$). This may indicate that the math prep course did not cover the type of math specific to nursing, such as metric equivalencies, household and apothecary systems, and drug

dosage calculation. In addition, the math prep course does not cover nursing abbreviations, which is incorporated in the word problems on the first nursing math exam.

Table 5

T-test for Equality of Means of Math Prep

		t	df	Sig. (2tailed)	Mean Difference
Accuplacer	Equal	10.061	38	.000	41.5213
	variances				
	assumed				
	Equal	9.679	22.535	.000	41.5213
	variances				
	not assumed				
Test One	Equal	3.425	31	.002	8.5846
	variances				
	assumed				
	Equal	2.972	15.464	.009	8.5846
	variances				
	not assumed				

Table 6, T-test for Equality of Means of Math Modules and Math Prep, reveals there was no statistical difference between math prep, modules, and the first nursing math exam scores. However, those that completed the math modules scored slightly higher than math prep ($t = -.196$; $p = .850$). This seems to indicate that of the two forms of remedial work students are able

to choose, students should be encouraged to complete the developmental math modules over the math prep. The modules appear to cover math more specific to the profession of nursing, thus, more adequately preparing students for the first nursing math exam.

Table 6

T-test for Equality of Means of Math Modules and Math Prep

		t	df	Sig. (2-tailed)	Mean Difference
Accuplacer	Equal	1.437	22	.165	12.0737
	variances				
	assumed				
	Equal	1.810	9.290	.103	12.0737
Test One	variances				
	not assumed				
	Equal	-.197	16	.846	-1.0154
	variances				
	assumed				
	Equal	-.196	7.209	.850	-1.0154
	variances				
	not assumed				

Question 3: What is the relationship between student grades in math prep and their score on the first nursing math exam?

Pearson r was performed to answer research question three and is displayed in Table 7, Correlation of Scores Before Taking Math Prep and Scores on First Nursing Math Exam. Of the students who completed math prep, the higher the course grade earned, the better the student tended to do on their first nursing math exam. How students scored in their math prep course did not seem to influence their first nursing math exam scores. The correlation was not found to be statistically significant at the .05 level, ($r = .387$; $p = .191$). This result may indicate that students basic math skill improved by completing the math prep coursework, however, the type of math on the first nursing exam is more directly related to nursing skills, incorporating nursing abbreviations, drug dosage word problems, and other math equations specific to the field of nursing.

Table 7

Correlation of Scores Before Math Prep and Scores on First Nursing Math Exam

		Math Prep	Test One
Math Prep	Pearson Correlation	1	.387
	Sig. (2-tailed)		.191
	N	19	13
Test One	Pearson Correlation	.387	1
	Sig. (2-tailed)	.191	
	N	13	13

Question 4: What is the relationship of students' scores before taking the developmental math modules and their scores on the first nursing math exam?

Pearson r was performed to address research question four and is represented in Table 8, Correlation of Student Scores Before Taking the Developmental Math Modules and Scores on the First Nursing Math Exam. Of the students who completed the developmental math modules

(using a composite score), math modules did impact the scores on the first nursing math exam but it was found not to be statistically significant at the .05 level. ($r = .371$; $p = .629$). Scores on the first nursing exam were higher for those students completing math modules. This would seem to suggest to the researcher that the developmental math modules designed by nursing faculty at FVTC, adequately represents the math competency required for nursing students prior to clinical experience. This might also indicate that students should be encouraged to complete the independent math modules as a form of remedial work rather than completing the math prep course. That the result was found not to be statistically significant may be the result of only five students in this study choosing the developmental math modules as type of remedial work.

Table 8

Correlation of Student Scores Before Taking the Developmental Math Modules and Scores on the First Nursing Math Exam

		Test One	Modules
Test One	Pearson	1	.371
	Correlation		
	Sig. (2-tailed)		.629
	N	38	4
Modules	Pearson	.371	1
	Correlation		
	Sig. (2-tailed)	.629	
	N	4	4

Question 5: What is the relationship of students Accuplacer cut score of 80% or better and the score on their first nursing math exam?

Pearson r was performed to address research question five. Data is represented in Table 9, Correlation of Student Scores on Achieving the 80% Cut Score and Scores on the First Nursing Math Exam, and found not to be statistically significant at the .05 level ($r = .334$; $p = .162$). This

may indicate that although students were able to demonstrate mathematical competency by achieving an 80% cut score, the student was not able to demonstrate mathematical competency specific to the field of nursing, as demonstrated in the first nursing math exam. Perhaps a math entrance exam score of 80% is too high and should be reevaluated based on math specific to the program area.

The results of this study also indicate that the math ACCUPLACER may not be the entrance test of choice for nursing students. The results also suggest that students would benefit by taking a nursing math course concurrently with first semester nursing courses, as a means of retaining basic mathematical skills and math skills specific to the field of nursing.

Table 9

Correlation of Student Scores of Achieving the 80% Cut Score and Scores on First Nursing Math Exam

		Test One	ACCUPLACER
Test One	Pearson	1	.334
	Correlation		
	Sig. (2-tailed)		.162
	N	19	19
Accuplacer	Pearson	.334	1
	Correlation		
	Sig. (2-tailed)	.162	
	N	19	21

Question 6: What is the relationship of students' scores before taking math prep or developmental math modules and their score on the first nursing math exam?

Table 10

Relationship of Student Scores Before Remedial Work and Their First Nursing Math Exam

		Test One	ACCUPLACER
Accuplacer	Pearson	1	-.163
	Correlation		
	Sig. (2-tailed)		.595
	N	19	13
Test One	Pearson	-.163	1
	Correlation		
	Sig. (2-tailed)	.595	
	N	13	13

Pearson r was performed to answer research question six. In Table 10, Relationship of Student Scores Before Remedial Work and Their First Nursing Math Exam, results indicate an inverse relationship was found; those who had higher ACCUPLACER scores, tended to have lower scores on their first nursing math exam. It was found not to be statistically significant at the .05 level, ($r = -.163$; $p = .595$). This may be the result of the type of mathematical equations asked on the first nursing math exam. Many of the questions on the first nursing math exam

incorporate medical terminology, medical abbreviations, metric equivalencies, household and apothecary equivalencies in the format of word problems, specific to field of nursing.

This may also be the result of students having no exposure to math since the math ACCUPLACER entrance exam. Students are told they will be expected to complete the math competency but are given little to no math instruction. Faculty are assuming that students who are able to achieve an 80% cut score on ACCUPLACER are adequately prepared to complete the math on the first nursing math exam.

Question 7: What is the number of practical nursing students that failed the practical nursing program based on inability to pass a nursing math exam after three attempts?

Of the 45 students admitted to the practical nursing program between June 2001-2003, four students failed the nursing math exam on the third attempt. Table 11, Number of Students Who Failed the Practical Nursing Program Due to Math Competency Exam, reveals the student ACCUPLACER entrance exam score, the scores on either their math prep course or math modules, and the three individual test scores on the nursing math exam.

Students were given three attempts to pass the nursing math exam. If after three attempts, a score of 85% was not achieved, students were dismissed from the practical nursing program. Four students failed the nursing math exam after three attempts. Table 11, Number of Students Who Failed the Practical Nursing Program Due to Math Competency Exam, show student scores on the three individual math exams. Though scores on each math test seem to improve, the score of 85% was not achieved. Validity of the subsequent test scores could be due to re-testing. This seems to indicate that students need continual exposure to nursing math equations prior to, and while a student in the practical nursing program.

Table 11

Number of Students Who Failed the Practical Nursing Program Due to Math Competency Exam

	ACCP	Math	Mod	Mod	Mod	Mod	Mod	Test	Test	Test
		Prep	1	2	3	4	5	1	2	3
<u>1</u>	<u>68</u>		<u>85</u>	<u>85</u>	<u>85</u>	<u>89</u>	<u>68</u>	<u>66</u>	<u>74</u>	<u>82</u>
<u>2</u>	<u>56</u>	<u>C</u>						<u>65</u>	<u>74</u>	<u>80</u>
<u>3</u>	<u>84</u>							<u>84</u>	<u>83</u>	<u>80</u>
<u>4</u>	<u>20</u>	<u>B</u>						<u>80</u>	<u>70</u>	<u>84</u>

Note. ACCP = ACCUPLACER; Mod = Module

The fact that four students were dismissed from the nursing program because of inability to demonstrate math competency is significant and should not be overlooked. As revealed in the literature review, nursing students and practicing nurse's struggle with math competency as it relates to nursing. This suggests that students would benefit from continual exposure to math specific to the field of nursing, throughout the practical nursing program.

Chapter V

Summary, Conclusions and Recommendations

Summary

The purpose of this study was to determine the relationship between the current math ACCUPLACER cut score of 80% and the successful completion of the math prep course or developmental math modules to academic preparedness in the shared practical nursing program at Nicolet Area Technical College. This study included three cohorts of nurses from June 2001 through June 2003.

The literature review focused on the content and validity of the ACCUPLACER college entrance exam, the history, development, and content of the nursing math modules, the math competency required of nursing students and practicing nurses, and medication/dosage calculations skills necessary for the nursing student and practicing nurses. The overall findings from the literature review reveal that there are significant problems with the ability of student nurses, graduate nurses and practicing nurses demonstrating mathematical competency as it relates to the fundamental skills of nursing.

Forty-five practical nursing students participated in this study. The sample selection was drawn from all students entering the practical nursing program June of 2001, 2002, and 2003, at Nicolet Area Technical College. Students selected had previously completed course work in nursing assistant, communications, and anatomy and physiology.

Instrumentation used in this study included: a) a standardized score for prior math knowledge using the ACCUPLACER entrance examination, b) percentage score for math competency on individual math modules, c) percentage scores representing course grades in math prep course, and d) spread sheet developed by the researcher to record the data gathered.

Conclusions

Based on the statistical findings for the sample of practical nursing students, the following conclusions were made about the 7 research questions. Each research question was answered in Chapter 4, Analysis and Discussion of Findings, and the following conclusions are made:

1. Previous math achievement as evidenced by an 80% cut score on the ACCUPLACER entrance exam was found not to have a significant relationship to scores on student's first nursing math exam.
2. Although there was no statistically difference between the math prep or developmental math modules, and scores on the first nursing math exam, the math modules scored slightly higher.
3. Grades earned in the math prep course did appear to help students on their first nursing math exam. The math prep course is beneficial, however, the math is basic mathematical equations and students in this study would have benefited from math equations specific to the math that is encountered on the job, as a professional nurse.
4. Scores on the first nursing exam were higher of those students completing math modules. This would suggest that the developmental math modules designed by nursing faculty at FVTC, adequately represents the math competency required for nursing students prior to clinical experience. This information should be shared with faculty advising students into the practical nursing program. Program advisors should encourage students to complete the five independent math module's as the form of remedial work that appears to best prepare students for the math the student will encounter in the program and on the job.
5. Of the 21 students who achieved the 80% cut score on the ACCUPLACER entrance exam, 2 students were not able to pass the first nursing math exam. Two other students achieved the

minimum passing score of 85%. This indicates that although the students were able to demonstrate mathematical competency by achieving an 80% cut score, the ACCUPLACER may not test the math skills that nursing faculty would like it to. It also indicates that a score of 80%, may be too high for entering nursing students and more focus should be placed on development of a math course more specific to the field of nursing.

6. Questions on the math ACCUPLACER do not include medical terminology, medical abbreviations, metric equivalencies, or household and apothecary equivalencies specific to the field of nursing. Though students scored well on the ACUCPLACER, those that did not achieve the 85% pass rate on the first nursing exam or those that just met the minimum requirement, had little to no math instruction specific to the field of nursing.

7. Students continue to struggle with math competency while in clinical, even after demonstrating math competency in the classroom.

Recommendations

The following recommendations are based on the results of this study:

1. The results of this study warrant that students be advised to take a college prep math course. As the health occupations advisor for the practical nursing program at NATC, students should be encouraged to complete a mathematics course, or the developmental math modules developed by FVTC, prior to entry into the practical nursing program.
2. Results of this study should be shared with all nursing faculty and basic education faculty at NATC. Discussions between both groups of faculty should focus on the possibility of students completing the developmental math modules, as the remedial work required for entry into the practical nursing program.

3. The information from this study should be shared with faculty advising students into the practical nursing program. Program advisors should encourage students to complete the five independent math module's as the form of remedial work that appears to best prepare students for the math the student will encounter in the program and on the job.
4. With the current shortage of nurses in Wisconsin, and across the nation, nursing programs may be denying students admission into nursing programs unfairly based on math scores.

Recommendations for Future Research

1. Further research should address the math competency required of practicing nurses. Nurses seem to be working in less than ideal circumstances, with nurse patient ratios of 1:8 or greater. This may be a variable that is affecting nurse math competency in the clinical setting (L. Mangles, personal communication, October 20, 2003).
2. Research should address ways to increase math competency of nursing students and practicing nurses. A suggestion as presented in the literature review, is further research into the use of algorithm calculators for students and practitioners, and the need for continuing education in dosage calculation for the practicing nurse.
3. Further research should address the number of dosage calculation errors related to math competency of nursing students and practicing nurses. Determining the amount of time and money spent on complications that arise as a result of inappropriate dosing, could lead to significant cost savings for health care providers at a time when health care cost is at its highest.
4. This study should be repeated in 3-5 years to determine if math scores of students have changed and to determine new or emerging math competencies needed by nurses.

Finally, it is hoped that this study reveals the need for healthcare providers and nursing programs across the country, to continue to research ways to improve math competency of

practicing nurses and student nurses. Through continued research it is hopeful and likely that patients remain safe, as a result of dramatically lessening the chance for medication errors and dramatically lessening the cost of healthcare resulting from drug dosage errors.

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